CLAIMS

1. A multi-layered endless belt having a structure of being constructed with a nonthermoplastic polyimide resin layer and an adhesive layer formed from at least one selected from the group consisting of epoxy resin, silicone resin, vinyl ester resin, phenolic resin, unsaturated polyester resin, bismaleimide resin, urethane resin, melamine resin, and urea resin, and being wound to construct a laminate body.

2. A multi-layered endless belt constructed with a nonthermoplastic polyimide resin layer and a thermoplastic resin layer made of a thermoplastic polyimide resin or at least one resin selected from the group consisting of polyether sulfone, polyethylene terephthalate, polyethylene naphthalate, polyether ether ketone, polyphenylene sulfide, polyetherimide, polysulfone, polyamideimide, polyetheramide, and polyarylate, wherein the nonthermoplastic polyimide resin layer and the thermoplastic resin layer are wound and alternately formed.

3. The multi-layered endless belt according to claim 1 or 2, wherein a smooth winding finishing end is formed.

4. The multi-layered endless belt according to claim 1 or 2, wherein a smooth winding starting end is formed.

5. The multi-layered endless belt according to claim 1

or 2, wherein an innermost circumferential layer having a smooth winding starting end and an outermost circumferential layer having a smooth winding finishing end are formed.

6. A production method of a multi-layered endless belt, comprising:

a laminate film forming step for forming a laminate film by disposing an adhesive layer formed from at least one selected from the group consisting of epoxy resin, silicone resin, vinyl ester resin, phenolic resin, unsaturated polyester resin, bismaleimide resin, urethane resin, melamine resin, and urea resin, on an entire surface or a specific portion of one surface or both surfaces of a nonthermoplastic polyimide film;

a winding step for winding the laminate film at least two times around an axial core; and

a heat-bonding step for heat-bonding the laminate film wound around the axial core with a heat source disposed in the inside and/or on the outside of the axial core.

7. A production method of a multi-layered endless belt, comprising:

a laminate film forming step for forming a laminate film by disposing a thermoplastic resin layer made of a thermoplastic polyimide resin or at least one resin selected

from the group consisting of polyether sulfone, polyethylene terephthalate, polyethylene naphthalate, polyether ether ketone, polyphenylene sulfide, polyetherimide, polysulfone, polyamideimide, polyetheramide, and polyarylate, on an entire surface or a specific portion of one surface of a nonthermoplastic polyimide film;

a winding step for winding the laminate film around an axial core for two or more winds; and

a heat-welding step for heat-welding with a heat source disposed in the inside and/or on the outside of the axial core.

8. A production method of a multi-layered endless belt, comprising:

a laminate film forming step for forming a laminate film by disposing a thermoplastic resin layer made of a thermoplastic polyimide resin or at least one resin selected from the group consisting of polyether sulfone, polyethylene terephthalate, polyethylene naphthalate, polyether ether ketone, polyphenylene sulfide, polyetherimide, polysulfone, polyamideimide, polyetheramide, and polyarylate, on an entire surface or a specific portion of both surfaces of a nonthermoplastic polyimide film;

a winding step for winding the laminate film around an axial core for two or more winds; and

a heat-welding step for heat-welding with a heat source disposed in the inside and/or on the outside of the axial core.

9. A production method of a multi-layered endless belt, comprising:

a film producing step for producing a film made of a nonthermoplastic polyimide resin and a thermoplastic resin film made of a thermoplastic polyimide resin or at least one resin selected from the group consisting of polyether sulfone, polyethylene terephthalate, polyethylene naphthalate, polyether ether ketone, polyphenylene sulfide, polyetherimide, polysulfone, polyamideimide, polyetheramide, and polyarylate;

a delivering step for delivering the nonthermoplastic polyimide resin film and the thermoplastic resin film;

a winding step for laminating and winding the nonthermoplastic polyimide resin film and the thermoplastic resin film simultaneously for two or more winds around an axial core; and

a heat-welding step for heat-welding with a heat source disposed in the inside and/or on the outside of the axial core.

10. The production method of a multi-layered endless belt according to any one of claims 6 to 9, comprising a step of performing one or more surface treatments selected from the group consisting of an ozone processing, a coupling agent processing, a blast processing, and an etching processing, on said film.

11. The production method of a multi-layered endless belt according to any one of claims 6 to 9, wherein the axial core constructed with an axial core main body and an attachable and detachable thin tube fitted onto the axial core main body is used in said winding step.

12. The production method of a multi-layered endless belt according to claim 11, wherein the attachable and detachable thin tube having an adhesion preventive layer disposed on a surface thereof is used in said winding step.

13. The production method of a multi-layered endless belt according to any one of claims 6 to 9, wherein the winding step is performed under a reduced pressure atmosphere in said winding step.

14. A production method of a medium conveying belt having an electrically conductive electrode pattern on an outer circumferential surface of a multi-layered endless belt and further having an electrode protective layer on an outer circumferential surface of the electrode pattern, the

production method comprising:

a step of preparing a material film according to any one of claims 6 to 9 or a thermoplastic resin film;

a step of preparing a film with an electrode pattern by forming an electrode pattern for one circumferential length of a tubular object at one end on one surface of a monolayer film of the material film or thermoplastic resin;

a winding step of winding the film with the electrode pattern at least two times around an axial core so that the electrode pattern forms the outermost circumferential surface, and further winding a resin film for forming the electrode protective layer at least two times on a surface of the electrode pattern; and

a heat-welding step of heat-welding the film with the electrode pattern and the resin film for the electrode protective layer which are wound around the axial core.

15. A production method of a medium conveying belt having an electrically conductive electrode pattern on an outer circumferential surface and an inner circumferential surface of a multi-layered endless belt and further having an electrode protective layer on an outer circumferential surface of the electrode pattern, the production method comprising:

a step of preparing a material film according to any one of claims 6 to 9 or a thermoplastic resin film;

a step of preparing a film with an electrode pattern by forming an electrode pattern for one circumferential length of a tubular object each at one end on one surface and at the other end on the opposite surface of the material film or thermoplastic resin film;

a winding step of winding the film with the electrode pattern at least two times around an axial core so that one electrode pattern forms the outermost circumferential surface and the other electrode pattern forms the innermost circumferential surface, and further winding a resin film for forming the electrode protective layer at least two times on a surface of the electrode pattern; and

a heat-welding step of heat-welding the film with the electrode pattern and the resin film for the electrode protective layer which are wound around the axial core.

16. A production method of a medium conveying belt having an electrically conductive electrode pattern on an outer circumferential surface of a multi-layered endless belt and further having an electrode protective layer on an outer circumferential surface of the electrode pattern, the production method comprising:

a step of preparing a material film according to any

one of claims 6 to 9 or a thermoplastic resin film;

a step of preparing a film with an electrode pattern by forming an electrode pattern for one circumferential length of a tubular object on a part of one surface of a laminate film or the thermoplastic resin film;

a winding step of winding the film with the electrode pattern at least two times around an axial core; and

a heat-welding step of heat-welding the film with the electrode pattern wound around the axial core.

17. A production method of a medium conveying belt having an electrically conductive electrode pattern on an outer circumferential surface and an inner circumferential surface of a multi-layered endless belt and further having an electrode protective layer on an outer circumferential surface of the electrode pattern, the production method comprising:

a step of preparing a material film according to any one of claims 6 to 9 or a thermoplastic resin film;

a step of preparing a film with an electrode pattern by forming an electrode pattern for one circumferential length of a tubular object on a part of one surface of a laminate film or the thermoplastic resin film and forming an electrode pattern for one circumferential length of a tubular object at one end of the opposite surface;

a winding step of winding the film with the electrode pattern at least two times around an axial core so that the electrode pattern at one end of the opposite surface forms the innermost circumferential surface; and

a heat-welding step of heat-welding the film with the electrode pattern and the resin film for the electrode protective layer which are wound around the axial core.

18. A production method of a medium conveying belt of a structure having an electrically conductive electrode pattern on an outer circumferential surface of a multi-layered endless belt and further having an electrode protective layer on an outer circumferential surface of the electrode pattern, the production method comprising:

a step of preparing a material film according to any one of claims 6 to 9 or a thermoplastic resin film;

a step of drilling a hole through a monolayer film of the material film or the thermoplastic resin film so that the electrode pattern of the electrode protective layer will be exposed to the inside of the medium conveying belt after winding and heating, or preparing a film narrower than the electrode protective film in a direction perpendicular to the circumferential direction;

a winding step of winding the film with the electrode pattern at least two times around an axial core, and further

winding a resin film for forming the electrode protective layer, which has the electrode pattern formed thereon, at least two times; and

a heat-welding step of heat-welding the film and the resin film for the electrode protective layer with the electrode pattern, which are wound around the axial core,

whereby an electric power can be supplied from the inside of the belt in applying a voltage to the electrode pattern between the two layers.

19. A production method of a medium conveying belt of a structure having an electrically conductive electrode pattern on an outer circumferential surface of a multi-layered endless belt and further having an electrode protective layer on an outer circumferential surface of the electrode pattern, the production method comprising:

a step of preparing a material film according to any one of claims 6 to 9 or a thermoplastic resin film;

a step of forming a film with an electrode pattern by forming an electrode pattern for one circumferential length of a tubular object at an end on one surface of the material film or the thermoplastic resin film;

a winding step of winding the film with the electrode pattern at least two times around an axial core so that the electrode pattern at one end of the opposite surface

forms the innermost circumferential surface; and

a heat-welding step of heat-welding the film and the resin film for the electrode protective layer narrower than the film in a direction perpendicular to the circumferential direction, which are wound around the axial core; and

a post-processing step of bending the end together with the electrode pattern to the inside of the medium conveying belt for contact-bonding by heating, after molding the belt,

whereby an electric power can be supplied from the inside of the belt in applying a voltage to the electrode pattern between the two layers.

20. The production method of a medium conveying belt according to any one of claims 14 to 19, wherein an electrical conduction is established between the electrode pattern and the inside surface of the medium conveying belt by drilling a hole through the medium conveying belt and forming a through-hole with an electrically conductive paste, or by processing with an electrically conductive fiber using a sewing machine, or by using an eyelet, a stapler, or another method, whereby an electric power can be supplied from the inside of the belt in applying a voltage to the electrode pattern between the two layers.

21. The production method of a multi-layered endless belt

according to any one of claims 14 to 19, wherein the axial core used in said winding step comprises a main body and an attachable and detachable thin metal layer fitted onto the main body.

22. The production method of a multi-layered endless belt according to claim 21, wherein said attachable and detachable thin metal layer has an adhesion preventive layer disposed on a surface thereof.

23. The production method of a medium conveying belt according to any one of claims 14 to 19, wherein said heat-welding step comprises:

a step of attaching a tubular cover bag on an outermost circumferential surface of the wound electrode protective layer to cover the whole of the film with the electrode pattern and the electrode protective layer with the cover bag; and

a step of heat-welding the film with the electrode pattern and the electrode protective layer in a state in which an outside of the cover bag receives a pressure higher than a pressure applied to an inside of the cover bag.

24. The production method of a medium conveying belt according to claim 23, wherein a surface roughness Ra of the inside of said tubular cover bag is at most 0.5 μ m.

25. The production method of a medium conveying belt according to claim 23, wherein a surface roughness Rz of the inside of said tubular cover bag is at most 2.0 μ m.

26. The production method of a medium conveying belt according to any one of claims 23 to 25, wherein the cover bag has a rubber elasticity.

27. The production method of a medium conveying belt according to any one of claims 14 to 26, wherein a filler having the maximum particle size of at most 5 μm is introduced into the material film or the thermoplastic resin film constituting said medium conveying belt.

28. The production method of a medium conveying belt according to any one of claims 14 to 26, wherein an electric power supplying part is disposed only on one side.

29. An endless belt molding apparatus constructed at least with a removable axial core and a heat-pressing apparatus having a barrier member mounted thereon, wherein there are two spaces that are partitioned by the barrier member between the axial core and the heat-pressing apparatus and the axial core has an outer circumferential surface for winding a film, and including a heat-processing mechanism and a pressure-processing mechanism via the barrier member for the film.

30. The endless belt molding apparatus according to claim 29, which is an apparatus having a hollow or solid axial core, a multiple tubular mold made of an outer tube surrounding the axial core, and an elastic body that partitions a space between the axial core and the outer tube as a fundamental construction, characterized in that the spaces on the axial core side and on the outer tube side with the elastic body lying therebetween (hereafter referred to as space a and space b) are independently capable of being subjected to pressure reduction and/or pressurization.

31. The endless belt molding apparatus according to claim 29, wherein the axial core is a tubular or cylindrical structural body attachable and detachable to the heat-pressurizing device and is capable of independently adjusting the pressures of the inner space (space c) of the axial core, the space (space d) between the axial core and the barrier member, and the space (space e) between the barrier member and the inside of the heat-pressurizing device.

32. The endless belt molding apparatus according to claim 29, wherein the axial core comprises an axial core main body and an endless tube of thin metal or heat-resistant resin which is attachably and detachably fitted onto the

axial core main body.

33. The endless belt molding apparatus according to claim 32, characterized in that the metal tube fitted onto the axial core main body has a thickness of at least 0.05 mm and at most 3 mm, preferably at least 0.15 mm and at most 2 mm.

34. The endless belt molding apparatus according to claim 32, characterized in that the heat-resistant resin tube fitted onto the axial core main body is made of a nonthermoplastic polyimide (hereafter represented as PI) having a thickness of at least 50 μm, preferably at least 150 μm and at most 2 mm.

35. The endless belt molding apparatus according to any one of claims 32, 33, 34, characterized in that a surface treatment having smoothness has been performed on a surface of the endless tube fitted onto the axial core main body.

36. An endless belt molding method using an endless belt molding apparatus according to claim 30, characterized by increasing a period of time for attaching the wound films while maintaining the space b in a reduced-pressure state, and reducing the pressure of the space a after the wound films are attached, or by reducing the pressures of the space a and the space b after the wound films are attached while maintaining initial gaps in a state of an ordinary

pressure (atmospheric pressure) as it is, so as to fully eliminate air between the wound films, and then introducing air or gas having a pressure higher than atmospheric pressure to the space b, and heating the whole wound films with heat supplied from a heating source while pressurizing the whole films via the elastic body, thereby to integrate the films for obtaining an endless belt.

37. The endless belt molding apparatus according to claim 31, characterized in that the axial core comprises a permeable member that does not hinder a permeability between the space a and the space b.

38. The endless belt molding apparatus according to claim 31, characterized in that said permeable member has pores having an average diameter at least 1 μm and at most 15 μm.

39. A molding method of an endless belt using the endless belt molding apparatus according to claim 31, the method comprising:

(1) a step of winding a film on an outer circumference of the axial core for one or more layers;

(2) a step of installing the axial core having the film wound thereon in the inside of said heat-pressing apparatus;

(3) a step of reducing the pressure of space c and space d to sufficiently remove air between the wound films;

(4) a step of applying a pressure to space e, pressurizing the whole films via the barrier member, and heating the whole wound films while maintaining a pressure;

(5) a step of cooling while maintaining said pressure; and

(6) a step of peeling off the molded endless belt from said axial core by pressurizing the space c to obtain an integrated endless belt.